

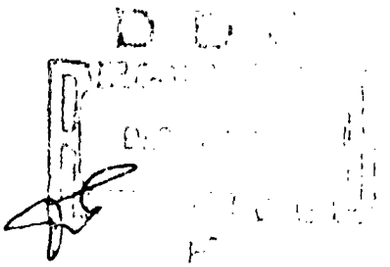
Technical Note 11-78

# AMMUNITION LOADING AND FIRING TEST—PRETEST

# PHYSICAL CONDITIONING OF FEMALE SOLDIER PARTICIPANTS



Marcia A. Murphy
Theresa M. Nemmers



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U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

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The purpose of this report is to present the physical conditioning program which was utilized in conditioning 13 female soldiers in order that they could successfully load and fire the 105mm (M101A1) and the 155mm (M114A1) howitzers. The program incorporated cardiovascular, strength, and endurance exercises.

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# PHYSICAL CONDITIONING OF FEMALE SOLDIER PARTICIPANTS

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October 1978

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## ACKNOWLEDGEMENT

Anthropometric data shown in Appendix A was compiled by Dr. Arthur A. Woodward, Jr., Personal Clothing/Equipment and Life Support Systems Team, Systems Performance and Concepts Directorate, US Army Human Engineering Laboratory.

Assistance in the physical conditioning program by CPT Paul F. Garrett, Jr., Personal Clothing /Equipment and Life Support Systems Team, Systems Performance and Concepts Directorate, US Army Human Engineering Laboratory.

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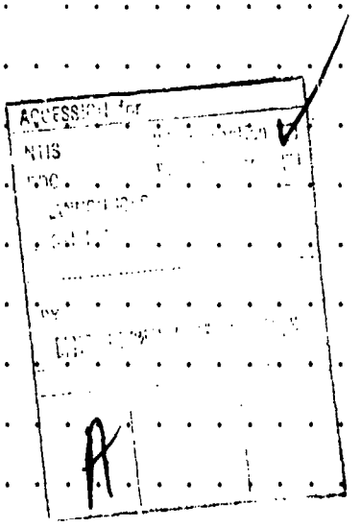

# AMMUNITION LOADING AND FIRING TEST--PRETEST

## PHYSICAL CONDITIONING OF FEMALE SOLDIER PARTICIPANTS

### INTRODUCTION

The influence of women on equipment design is reflected in current Army efforts to accommodate the female soldier in her ever expanding role. Women have been admitted into all military occupational specialties formerly considered "nontraditional" with the exception of the combined arms branches and combat engineers. The growing presence of women in the Army and their projected utilization are gaining increased interest at the congressional level.

The purpose of this report is to present the physical conditioning program which was utilized in conditioning 13 female soldiers in order that they could successfully load and fire the 105mm (M101A1) and the 155mm (M114A1) howitzers. The program was designed by analyzing the specific kinematics utilized in loading and firing the above mentioned howitzers. Anthropometric data is shown in Appendix A. Protocol submitted is exhibited in Appendix B. Universal gym exercises for strength and endurance are exhibited in Appendix C.

### PRELIMINARY CONSIDERATIONS

The training/physical conditioning regimen selected was based on physical requirements for ammunition/portability/handling/loading in FM 6-50(2). Heights, weights, etc., for the howitzers and rounds are shown in Table 1. Table 2 summarizes the actual physical demand for loading crews for each howitzer.

TABLE 1

Physical Parameters of Howitzers Relevant to Conditioning

| | Howitzer | |
|---|---|---|
| | 105mm | 155mm |
| Weight of Round | 33 lb. shell, 45 lb. compl. | 95 lb. shell |
| Length of Round | 31.07" | 26" |
| Loading Tray | NA | 19 lb., 34" long, 16" wide |
| Raming Staff (aluminum) | NA | 10 lb., 2 segments of 4'2" which fit together, 1.5" dia. |
| Force to Open Breech | 10 ft/lbs < | 50 ft/lbs |
| Trail Width | 4½" | 8¼" |
| Height of Breech from Ground | 43" | 46" |
| Height of Trail at Handover of Round | 24" | NA |
| Height of Handle of Breech from Ground | NA | 37" |
| Distance between Handle of Open Breech and Trail | NA | 24" |

TABLE 2

Loading Requirements Relevant to Conditioning

| | Howitzer | |
|---|---|---|
| | 105mm | 155mm |
| Distance to carry each round to howitzer | 8' - 10' | 8' - 10' |
| Distance to carry powder | NA | 3 lb - 6' |
| Crew size | 4 | 6 |
| Dead weight lift of round from ground to breech | Yes | Yes |
| Rounds/rate burst fire | 10/min for 3 min | 4/min for 3 min |
| Rounds/rate sustained fire (5 min limit) | 3/min | 1/min |
| Total training trial rounds/ crew-live fire | 4 | 4 |
| Total training trials/ crew-live fire | 5 | 5 |
| 1st test trial exposure time | 3 min | 3 min |
| 2d test trial exposure time | 8 min (burst & sustain) | 8 min (burst & sustain) |
| Total trials | 2 | 2 |
| Number of experimental trials/day/crew | no more than 4 | no more than 4 |
| Total number of experimental trials/crew | 4 | 4 |
| Total number of rounds/ crew | 75 | 29 |
| Total training rounds | 20 | 43 |

A multistation training machine (universal gym) was utilized for conditioning purposes. The time constraints on the conditioning phase required that an intensive, task specific program be developed. The subjects were required to be in good physical condition with no current or recent profile for ear, back, leg, knee, ankle, arm, wrist, or hand injury. The term good physical condition is used because the Army's medical fitness categories are good, fair, or poor.

## METHOD

The subjects (Ss) participated in a program which incorporated cardiovascular, strength, and endurance exercises discussed in detail further in the text. All training was done with the Ss wearing combat boots and fatigues. Each exercise period was preceded by warm up calisthenics and flexibility exercises and followed by cool down activities. The cardiovascular exercise was done daily; the strength and endurance exercises were done on alternate days.

The Ss were instructed in the proper method of checking their heart rate using either the radial or carotid pulse. During the exercise periods, the heart rate was allowed to increase to 120-150 beats per minute (not to exceed 150 beats per minute). During the rest time between exercises, each subject checked her own heart rate. Ss were instructed not to resume the exercises if the heart rate was not below 120 beats per minute within 5-10 minutes after cessation of the activity.

## SUBJECTS

The military occupational specialties (MOS) of the subjects are listed in Table 3.

TABLE 3

Subjects' Military Occupational Specialty

| Subject Number | MOS |
|---|---|
| 1 | Supply Specialist |
| 2 | Administrative Specialist |
| 3 | Personnel Records Specialist |
| 4 | Clerk Typist |
| 5 | Records Specialist |
| 6 | Clerk Typist |
| 7 | Machinist |
| 8 | Administrative Specialist |
| 9 | Supply Clerk |
| 10 | Veterinary Specialist |
| 11 | Automotive Repairman |
| 12 | Records Specialist |
| 13 | Chemical Laboratory Technician |

## PRE- AND POST-TESTING

It was desirable to have some estimate of each subject's physical condition before initiating the exercise program. Cooper's 12-minute running test for women (1) was chosen for this project because of its simplicity, ease of administration and reliability. This test was also used as a post test at the completion of the conditioning program. The test is displayed in Table 4.

TABLE 4

Women's Optional 12-Minute Running Test Distance (Miles)
Walked and Run in 12 Minutes

| Fitness Category | AGE (Years) | | | | |
|---|---|---|---|---|---|
| | Under 30 | 30 - 39 | 40 - 49 | 50 - 59 | 60+ |
| I. Very Poor | < .95 | < .85 | < .75 | < .65 | Not Recommended |
| II. Poor | .95-1.14 | .85-1.04 | .75- .94 | .65- .84 | |
| III. Fair | 1.15-1.34 | 1.05-1.24 | .95-1.14 | .85-1.04 | |
| IV. Good | 1.35-1.64 | 1.25-1.54 | 1.15-1.44 | 1.05-1.34 | |
| V. Excellent | 1.65+ | 1.55+ | 1.45+ | 1.35+ | |

< means "less than."

## CARDIOVASCULAR EXERCISES

The primary cardiovascular exercise was jogging. The Ss were placed in groups based upon the results of the 12-minute pretest run. The distance jogged was increased every 2 days. Table 5 outlines the jogging schedule.

## STRENGTH TRAINING

Four exercises on the universal weight machine were used in the strength training. These exercises were squats, forearm lift, dead lift and curl (nomenclature based on descriptive terms designated by the equipment manufacturers). Illustrations 1C through 4C depict these exercises (see Appendix C).

Each S was assisted in determining the maximum weight she could lift in one repetition of each exercise. The training sequence consisted of three sets of five repetitions, lifting 70 percent of the maximum weight with each repetition. The maximum weight was reestablished each week. One set of each exercise was completed before beginning the next set.

TABLE 5

Aerobic Schedule
(Half-Day Training)

| Day | Category Very Poor / Poor | Category Fair / Good / Excellent |
|---|---|---|
| 1 | 12 minute test | 12 minute test |
| 2 | .25 mile | .5 mile |
| 3 | .25 mile | .5 mile |
| 4 | .5 mile | 1.0 mile |
| 5 | .5 mile | 1.0 mile |
| 6 | .5 mile | 1.0 mile |
| 7 | 1.0 mile | 1.5 miles |
| 8 | 1.0 mile | 1.5 miles |
| 9 | 1.5 miles | 2.0 miles |
| 10 | 1.5 miles | 2.0 miles |
| 11 | holiday | holiday |
| 12 | 1.5 miles | 2.0 miles |
| 13 | 2.0 miles | 2.5 miles |
| 14 | 2.0 miles | 2.5 miles |
| 15 | 12 minute test | 12 minute test |

## ENDURANCE TRAINING

The endurance training included four exercises on the weight machine: bench press, leg press, situp on an incline board and back extension (see illustrations 5C through 8C in Appendix C). These exercises were done with light weights (situp and back extension were done without weights) in five sets of 15 repetitions. As in the strength training, one set of each exercise was completed before beginning the next set.

An example of a 5-day program is presented in Table 6.

TABLE 6

Five-Day Plan

First Day
(One-Half Day Only)

10 minutes of stretching and warm-up calisthenics.
12-minute Cooper aerobic run (this will determine what category Ss will be placed in for duration of jogging training program).
Cool-down .25 walk.

Second Day

10 minutes of stretching and warm-up calisthenics.
Determination of Ss strength weights and endurance weights.
Rest period.
Warm-up.
Jogging--using Day 1 of Table 5. Distance dependent on category.
Cool-down .25 walk.

Third Day

10 minutes of stretching and warm-up calisthenics.
Strength exercises (deadlift, curl, squats, forearm).
Cool-down.
Rest period.
Warm-up.
Jogging--using Day 2 of Table 5.
Cool-down .25 walk.

Fourth Day

10 minutes of stretching and warm-up calisthenics.
Endurance exercises (leg press, bench press, back extension, sit-ups).
Cool-down.
Rest period.
Warm-up.
Jogging--using Day 3 of Table 5.
Cool-down .25 walk.

Fifth Day

10 minutes of stretching and warm-up calisthenics.
Strength exercises.
Cool-down.
Rest period.
Warm-up.
Jogging--using Day 4 of Table 5.

## RESULTS

The pre- and post-test distances in the 12-minute run are recorded in Table 7. The average gain was 0.2 mile. This would appear to be a significant improvement considering that Cooper's values are based upon women running in shorts and tennis shoes as opposed to the Ss who ran in fatigues and combat boots.

TABLE 7

12-Minute Run
(Distance in Miles)

| Subject | Pre-Test Distance | Post-Test Distance | Gain |
|---|---|---|---|
| 1 | 0.9 | 1.0 | 0.1 |
| 2 | 1.1 | 1.1 | 0[a] |
| 3 | 0.9 | 0.9 | 0[b] |
| 4 | 1.2 | 1.5 | 0.3 |
| 5 | 1.2 | 1.4 | 0.2 |
| 6 | 1.3 | 1.5 | 0.2 |
| 7 | 1.0 | 1.2 | 0.2 |
| 8 | 1.1 | 1.5 | 0.4 |
| 9 | 0.9 | 1.1 | 0.2 |
| 10 | 0.8 | 1.0 | 0.2 |
| 11 | 0.9 | 1.1 | 0.2 |
| 12 | 1.0 | 1.2 | 0.2 |
| 13 | 0.9 | 1.1 | 0.2 |

Average gain - 0.2 mile

[a]Subject 2 missed the third week of training due to personal reasons.

[b]Subject 3 sustained a minor hamstring strain on the day preceding post-test run.

The strength of the Ss, as seen in the changes in the weights used in the strength training phase, also reveals some dramatic improvement. These figures are displayed in Table 8.

## DISCUSSION

The demonstrated increases in the distance covered in the 12-minute run and in the ability to lift an increased amount of weight are both positive indicators that the physical endurance of the Ss was improved.

During the development of the exercise program, it was observed that other, more sophisticated methods of measuring physical endurance should have been utilized. Time constraints, however, prohibited the development of a more detailed protocol and evaluation system.

TABLE 8

Recapitulation of Weights Used in Strength Training Phase

| Subject | Forearm[a] | Squats[a] | Curl[a] | Dead Lift[a] |
|---|---|---|---|---|
| 1 | 70/70 | 185/200 | 20/20 | 60/60 |
| 2 | 85/100 | 185/200 | 20/20 | 48/84 |
| 3 | 70/70 | 145/160 | 20/30 | 60/60 |
| 4 | 85/100 | 160/230 | 20/20 | 36/60 |
| 5 | 55/70 | 115/130 | 20/20 | 36/96 |
| 6 | 85/100 | 85/175 | 20/20 | 36/60 |
| 7 | 85/100 | 115/160 | 20/30 | 48/96 |
| 8 | 115/115 | 185/230 | 20/20 | 115/145 |
| 9 | 70/85 | 115/130 | 30/30 | 36/36 |
| 10 | 70/100 | 185/200 | 20/30 | 72/96 |
| 11 | 85/100 | 175/185 | 30/30 | 36/48 |
| 12 | 115/130 | 185/215 | 30/30 | 132/156 |
| 13 | 70/70 | 130/145 | 20/20 | 36/48 |
| average weight lifted | 82/98 | 150/180 | 22/25 | 58/80 |
| average gain | 11.5 | 30 | 2 | 23 |
| % average improvement | 14 % | 20 % | 9 % | 40 % |

[a]Numbers on left represent weight per pound at the beginning of the conditioning program; numbers on right represent weight per pound lifted at the termination of the conditioning program.

It should also be noted that there were no significant injuries incurred during this accelerated program.

## CONCLUSION

The physical training regimen for the artillery study has opened the door for further studies on the question of physical training programs of varying nature for the different Army job specialties.

Physical conditioning played a key role in the US Army Human Engineering Laboratory Ammunition Loading and Firing Test. Test directors wanted to see if women who are physically fit could maintain the strength and endurance necessary for the firing sequence. The rate of fire is 4 rounds-per-minute for the first 3 minutes, then 1 round-per-minute thereafter for the 155mm M114A1 towed howitzer; and 10 rounds-per-minute for the first 3 minutes, then 3 rounds-per-minute sustained for the 105mm M101A1 towed howitzer. The subjects not only met the rate of fire on both howitzers, but in several instances exceeded it.

## REFERENCES


1. Cooper, M., & Cooper, K.H. Aerobics for women. New York: M. Evans and Company, 1972.

2. Department of the Army. Field artillery cannon battery. Field Manual 6-50, Washington, DC.

3. Lea and Febiger. Guidelines for Graded Exercise Testing and Exercise Prescription. American College of Sports Medicine, Philadelphia, PA, 1976.

# APPENDIX A

# WOMEN'S ARTILLERY TEAM TRIALS

Body Sizes of Subjects

| Subject Number | Weight kg | Weight lb | Stature cm | Stature in |
|---|---|---|---|---|
| 1 | 60.8 | 133.8 | 159.4 | 62.8 |
| 2 | 67.0 | 147.5 | 163.6 | 64.4 |
| 3 | 57.3 | 126.1 | 155.0 | 61.0 |
| 4 | 58.8 | 129.3 | 161.0 | 63.4 |
| 5 | 51.2 | 112.5 | 170.8 | 67.2 |
| 6 | 64.8 | 142.5 | 170.3 | 67.0 |
| 7 | 61.6 | 135.5 | 178.3 | 70.2 |
| 8 | 70.1 | 154.3 | 171.2 | 67.4 |
| 9 | Data unavailable. | | Subject not present. | |
| 10 | 65.2 | 143.4 | 143.8 | 56.6 |
| 11 | 51.8 | 113.9 | 161.4 | 63.5 |
| 12 | 76.5 | 168.3 | 173.4 | 68.3 |
| 13 | 63.2 | 139.0 | 156.8 | 61.7 |

Statistical Summary

| | | | | |
|---|---|---|---|---|
| N | 12 | | 12 | |
| Mean | 62.36 | 137.19 | 163.75 | 64.47 |
| SD | 7.22 | 15.88 | 9.57 | 3.77 |
| Min | 51.2 | | 143.8 | |
| Percentile | 15th | | < 1st | |
| Max | 76.5 | | 178.3 | |
| Percentile | 96th | | 99th | |
| Mean, US Army Women | 59.97 | | 162.9 | |

# APPENDIX B

# PROTOCOL

# PROTOCOL

Experiment: USAHEL Ammunition Loading Test–Pretest Physical Conditioning of Female Soldier Participants.

Investigator: Personal Clothing/Equipment and Life Support Systems Team, Systems Performance and Concepts Directorate, US Army Human Engineering Laboratory (USAHEL).

1. Scope/Experiment Objective:

To select and attempt to condition 24 female soldiers stationed at Aberdeen Proving Ground, Maryland, to the extent that they will be physically capable of performing artillery loading tasks associated with the 105mm (M101A1) and 155mm (M114A1) howitzers. Experiment allots three weeks for conditioning/training, followed by one week for experimental, live-fire trials.

Training in loading procedures will run concurrently with physical conditioning, counterbalanced to avoid fatigue effects during ammunition handling/loading. "Hands on" training will begin as quickly as possible based on physical conditioning tests, and will continue up to scheduled live firings. This "hands on" training will use inert rounds,howitzer mockups and the actual howitzers to sharpen both individual and crew skills.

Although time constraints dictate training on both howitzers during pretrial weeks, all experimental trials will be completed by each crew for one howitzer at a time, thus minimizing negative transfer of training.

2. Concept of Test/Methodology:

Task Analysis

The training/physical conditioning regimen selected is based on physical requirements for ammunition portability/handling/loading in FM 6-50. Heights, weights, etc., for the howitzers and rounds are shown in Table 1B.

Table 2B summarizes the actual physical demands for loading crews for each howitzer.

Performance Assessment/Physical Conditioning Regimen

Method: The 24 female subjects will participate in a 3-week training program which will incorporate cardiovascular, strength and endurance exercises. Exercise will be done with the subjects wearing fatigues and combat boots. The equipment used for the strength and endurance training will be a multi-station weight training machine. Stretching and warm-up calisthenics will precede all exercise periods and all periods will end with stretching and walking to cool down.

Subjects will be instructed in the proper method of checking their heart rates. During exercise periods the heart rate will increase to 120-150 beats per minute (not to exceed 150 beats/min). During the rest period between tasks the subjects will check heart rate which should be below 120 beats per minute within 5-10 minutes after cessation of activity. A new activity will not be started unless the heart rate is within the acceptable limits.

TABLE 1B

Physical Parameters of Howitzers Relevant to Conditioning

| | Howitzer | |
|---|---|---|
| | 105mm | 155mm |
| Weight of Round | 33 lb shell, 45 lb compl. | 95 lb shell |
| Length of Round | 31.07 inches | 26 inches |
| Loading Tray | NA | 19 lb, 34 inches long, 16 inches wide |
| Ramming Staff (aluminum) | NA | 10 lb, 2 segments of 4'2" which fit together, 1.5" diameter. |
| Force to Open Breech | 10 ft/lbs < | 50 ft/lbs |
| Trail Width | 4½ inches | 8¼ inches |
| Height of Breech from Ground | 43 inches | 46 inches |
| Height of Trail at Handover of Round | 24 inches | NA |
| Height of Handle of Breech from Ground | NA | 37 inches |
| Distance between Handle of Open Breech and Trail | NA | 24 inches |

TABLE 2B

Loading Requirements Relevant to Conditioning

| | Howitzer | |
|---|---|---|
| | 105mm | 155mm |
| Distance to carry each round to howitzer | 8' - 10' | 8' - 10' |
| Distance to carry powder | NA | 3 lb - 6' |
| Crew size | 4 | 6 |
| Dead weight lift of round from ground to breech | Yes | Yes |
| Rounds/rate burst fire | 10/min for 3 min | 4/min for 3 min |
| Rounds/rate sustained fire (5 min limit) | 3/min | 1/min |
| Total training trial rounds/crew-live fire | 4 | 4 |
| Total training trials/ crew-live fire | 5 | 5 |
| 1st test trial exposure time | 3 min | 3 min |
| 2d test trial exposure time | 8 min (burst & sustain) | 8 min (burst & sustain) |
| Total trials | 2 | 2 |
| Number of experimental trials/day/crew | no more than 4 | no more than 4 |
| Total number of experimental trials/crew | 4 | 4 |
| Total number of rounds/crew | 75 | 29 |
| Total training rounds | 20 | 43 |

Cardiovascular Exercise: The primary cardiovascular exercise will be jogging. Subjects will be placed in groups based upon the results of aerobic testing, using the Cooper 12-min running test. The distance jogged each day will be based on aerobic testing and will be increased every other day.

Strength Training: Initially, subjects will be tested for maximum weight able to lift with one repetition. Training program will include 3 sets with 5 repetitions, each set with 70% maximum weight. Sets will not be in succession. Maximum weight will be adjusted each week.

Activities will include: (nomenclature based on descriptive terms designated by equipment manufacturer)

1. Squats
2. Dead lift (½ body weight only)
3. Curl
4. Forearm lift

Endurance Training: Exercise periods will be with light weights (10%-20% of body weight), 5 sets with 15 repetitions each set. Light weight will be adjusted each week.

Activities will include:

1. Leg press
2. Bench press
3. Back extension (without weights)
4. Sit-ups on incline board (without weights)

Risks

The risks during the physical conditioning period are no more than fatigue, physical exhaustion, muscle strain, cuts and abrasions. Risks during "hands on" howitzer loading (training and live fire trials) include burns, hearing threshold shifts, muscle/bone injury from contact with trails, foot injury from dropped rounds, etc.

Precautions

1. An interview and screening process will be conducted prior to final selection of the 24 female subjects. Subjects must be in good physical condition with no current or past profile of ear, back, leg, knee, ankle, arm, wrist or hand injuries. A vision profile is acceptable if correctable by the use of glasses (contact lenses are unacceptable). Subjects weighting less than 110 lbs cannot be utilized.

2. Subjects will be made aware at the initial interview of the nature of the test, tasks to be performed, and the level of physical performance expected. This is in agreement with SGO regulations, which in this case would clearly require volunteer consent forms. Subjects may drop out of the test at any time.

3. MTD, SOMTE have agreed to train the female subjects on the familiarization and firing of the actual weapons with their artillery personnel.

4. Prior to the first live firing, each crew member will have her ears examined by a medical specialist to insure that her ear canals are clean and healthy and that her ear drum is intact. Ear canals will be cleaned, as required. Crew members will be fitted with and instructed in the use of the appropriate size triple flange ear plug. Following the pre-exposure audiogram, crew members will be reissued the plugs; they will be fitted by the crew member in a diffuse sound field provided for this purpose in the on-site audiometric test facility (ATF); and the plugs will be checked visually by the facility personnel. The plugs will be worn throughout the test sequence. Immediately following each loading test, the crew members will return to the audiometric test facility, the plugs will be removed and retained at the ATF, and post-exposure audiometric testing will be completed.

The gun crews' hearing will be monitored during the tests to insure that excessive temporary hearing losses are avoided. Prior to the first live firing test, all of the crew personnel will be trained on the audiometric test procedure. A baseline audiogram will be established for each ear by repeated testing in the ATF. The ATF will provide audiometric conditions that meet or exceed the ANSI requirements for audiometric rooms.

During the loading test, the hearing of up to four crew members will be monitored, the most severely exposed personnel being selected for monitoring. A pre-exposure audiogram will be given just before the test and a post-exposure audiogram will be given beginning within 2 minutes following the end of the exposure.

Crew members having a threshold shift will not be re-exposed until their thresholds have recovered to within 5 dB of their pre-exposure level at each test frequency. Additional audiograms will be given at 24-hour intervals until the thresholds have stabilized.

Following each test sequence, crew members' comments will be solicited concerning any possible clinically significant symptoms they may have, and complaints will be followed up by appropriate medical/audiometric examination.

5. All of the projectiles and fuzes in this program will be inert. All subjects will go through a training program consisting of live firings of the inert ammunition to familiarize them with the tasks involved and the weapons to be used.

6. The Materiel Testing Directorate (MTD) will supply a test officer to insure that safety procedures and range regulations are adhered to. The design of the test, as well as the procedures involved, have been coordinated with them.

7. Female subjects will wear the prescribed uniform for all phases of training. For all howitzer performance training, the uniform will include M1 helmet liner, male combat boots and leather gloves for crewmember(s) removing spent casings from the breech.

Benefits

The female soldier participating in this study will acquire useful knowledge about her current level of cardiovascular functioning, muscular strength and endurance. She will also become familiar with the methods, schedules and techniques for improving her physical condition, and, in most cases, will complete the current course in better shape than she began.

In addition to improving her physical condition, the female soldier in this study will provide the Army with valuable data which may help to expand the traditionally limited view of the ability of women to perform physically demanding tasks.

# APPENDIX C

## UNIVERSAL GYM EXERCISES

## Universal Gym Exercises

Illustrations 1C through 4C depict strength exercises used in the study. Illustrations 5C through 8C depict endurance exercises used in the study

Illustration 1C - Squats

Procedure:

1. Assume comfortable stance facing machine, feet comfortable distance apart (generally shoulder width or more).
2. Keep back straight and lift with legs, not with your back.
3. Lift to full extension of legs.

Illustration 2C - Forearm Lift

Procedure:

1. Assume comfortable stance, feet shoulder width apart, facing machine.
2. From slightly crouched position, place tops of forearms on bottom of lift arm pads
3. Lift upward with forearms with explosive movements (generally).

Muscles Involved in Illustrations 1 and 2 (primarily):

1. Quadriceps (thigh muscle)
2. Gluteus maximus (extends thigh)
3. Hamstrings
4. Gastrocnemius (calf)
5. Soleus deltoids

Illustration 3C - Dead Lift

Procedure:

1. Assume dead lift position with one foot in front of the other, facing machine between handles.
2. Squat down, bending at knees and hips, and grasp lift handles.
3. Keep head up and back straight.
4. Lift desired weight by extending legs and hips (stand up straight).

Illustration 4C - Curl

Procedure:

1. Stand facing the machine.
2. Grasp lift handles.
3. "Pin" elbows to your side.
4. Lift forearms and hands up and toward your face while grasping lift bar.

Illustration 5C - Bench Press

Procedure:

1. Assume comfortab.e supine (face up) position with lift bar theoretically over chest.
2. Grasp lift handles.
3. Lift bar to full extension of arms.

Muscles Involved in Illustrations 3, 4, and 5 (primarily):

1. Pectoralis major (relating to chest)
2. Triceps
3. Anterior deltoid obliques
4. Rectus abdominus
5. Transversalis quadriceps (thigh muscle)
6. Gluteus maximus trapezins (extends thigh)
7. Biceps
8. Brachailis (relating to arm)

Illustration 6C - Leg Press

Procedure:

1. Adjust seat to desired distance (try less than 90 degree angle at knee when feet are on pedals).

2. Grasp handles.

3. Keep back flat against chair.

4. With feet on bottom pedals, fully extend the legs.

Muscles Involved in Illustration 6 (primarily):

1. Quadriceps (thigh muscle)

2. Hamstrings

3. Buttocks gastrocnemius (calf)

4. Soleus (sole of the foot)

Illustration 7C - Situps

Procedure:

1. Take seated position on bench, facing unit, with fronts of legs under roller pads.
2. Place arms in front across waist.
3. Lower body.
4. Raise body (sit up).

Illustration 8C - Back Extension

Procedure:

1. Assume starting position by placing back of legs under roller pads so lower abdomen is on bench top, face down position.
2. Place arms along side of body.
3. Lower body as far as possible by bending at waist.
4. Raise trunk and head, with arms at side, to a position parallel to the floor.

Muscles Involved in Illustrations 7 and 8 (primarily):

1. Erector spinae muscle group
2. Gluteus maximus (extends thigh)
3. Hamstrings
4. Stomach muscle